Spatiotemporal variations in extreme precipitation in the contiguous USA and the Madden-Julian Oscillation (MJO)

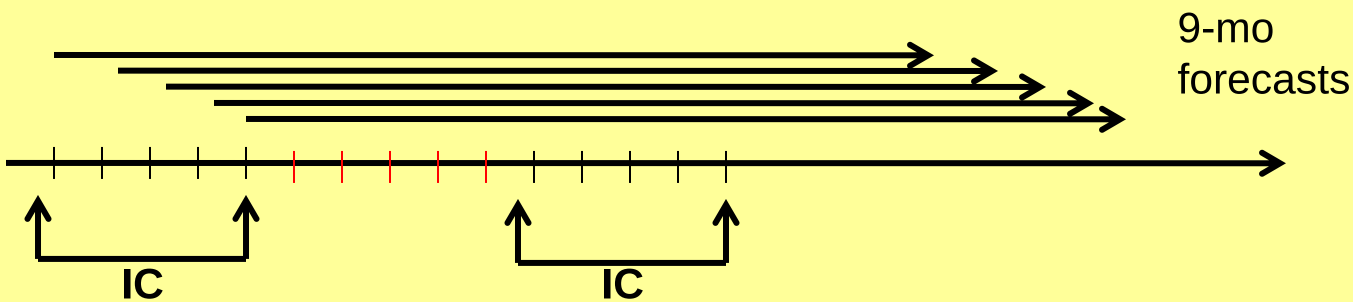
Charles Jones[1], Leila Carvalho[1], Jon Gottschalk[2]

[1]University of California, Santa Barbara
[2]Climate Prediction Center (CPC/NCEP)

CTB Project: Probabilistic forecasts of extreme events and weather hazards over the United States (Jul 08-Dec 11)

Quick review of previous results

CFS Reforecasts Version 1



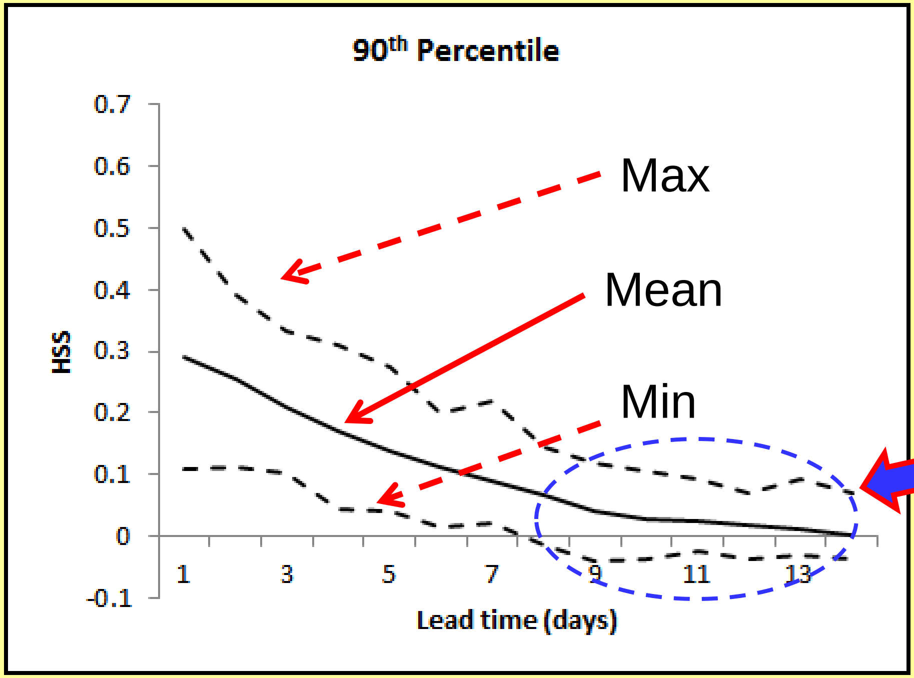
- 15 initial conditions per month
- Forecasts out to 270 days; we analyzed forecasts out to 4 weeks
- Analyzed deterministic and probabilistic forecast skill of extreme P
    - P > 75th percentile P > 90th percentile

➡ However, **CFSR.v1** difficult to investigate importance of MJO on **probabilistic forecasts** of extreme P

➡ **CFSR.v2** offers much higher number of ensemble members

Jones, C., J. Gottschalck, L. M. V. Carvalho, and W. Higgins, 2011: Influence of the Madden-Julian Oscillation on forecasts of extreme precipitation in the contiguous United States. *Monthly Weather Review*, 139, 332-350.

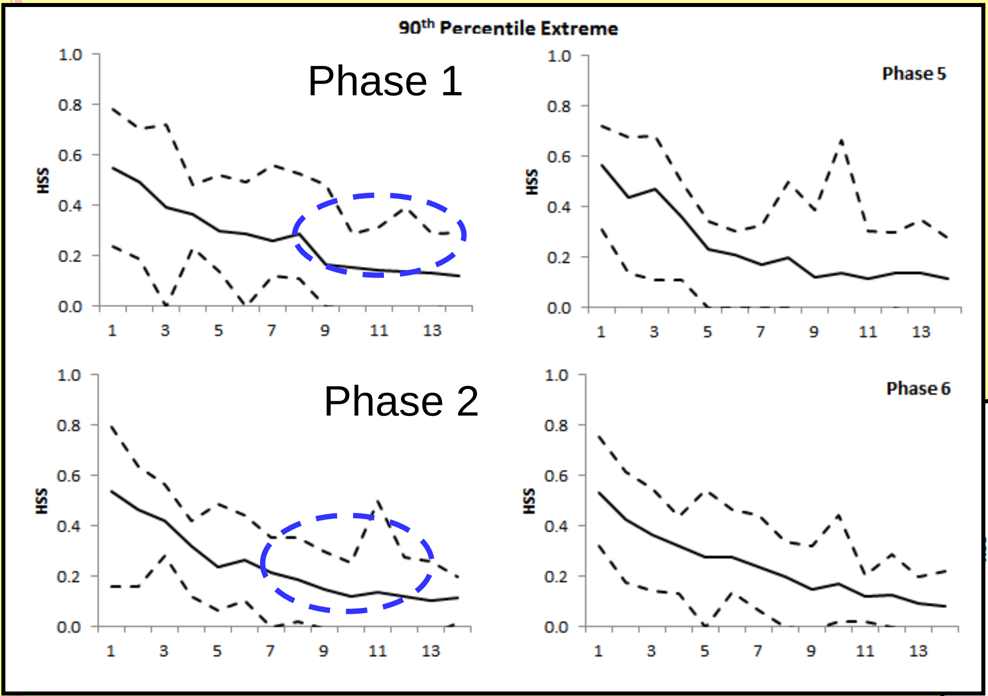
Heidke Skill Score (HSS) 90th percentile extreme Precipitation over the western CONUS



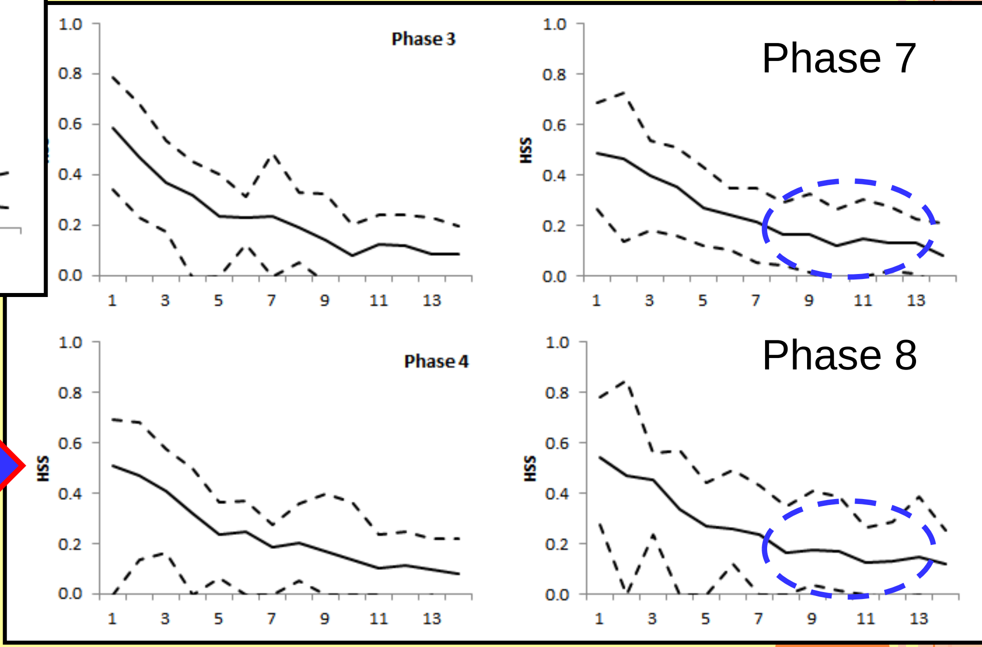
Low skill in Week-2

Week-1 **Week-2**

When the MJO is active ….



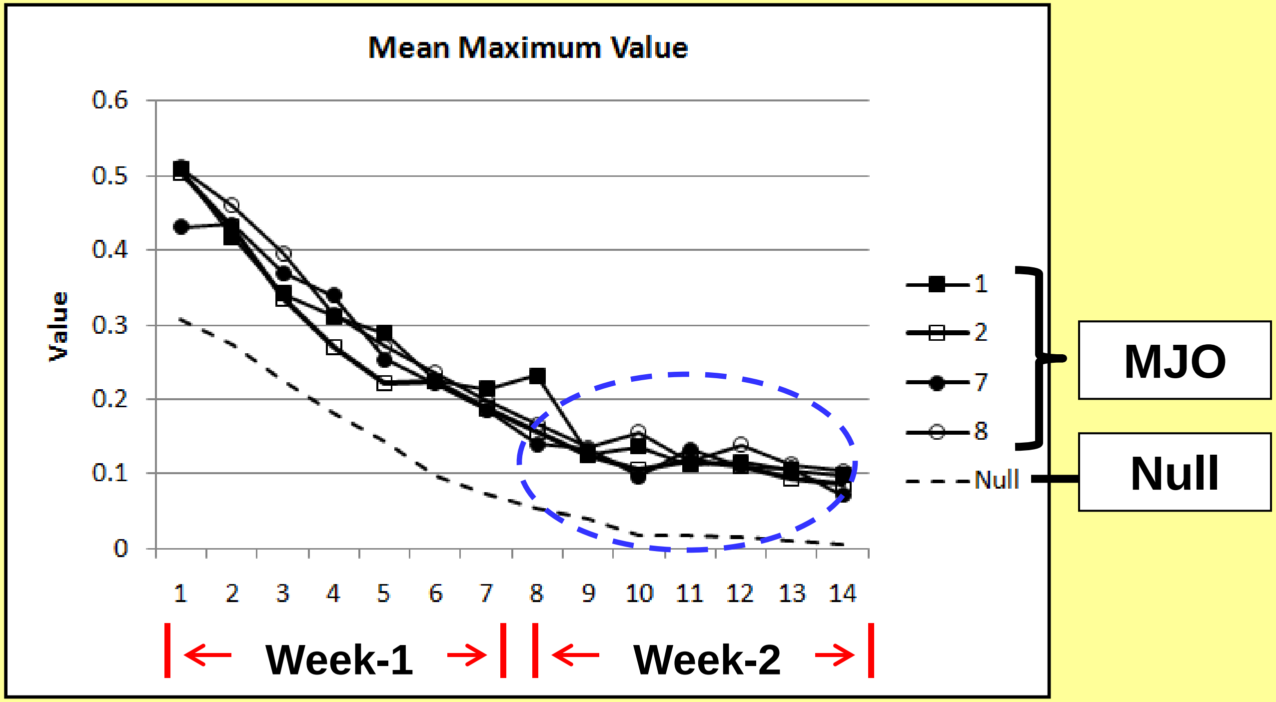
HSS is higher and extends to longer leads (Week-2)



The HSS of extreme precipitation (90th percentile) forecasts during each MJO phase. Solid lines represent the average over grid points that are significant at 5% level. Upper (lower) dashed lines indicate the max (min) HSS values.

Jones, C., L. M. V. Carvalho, J. Gottschalck and W. Higgins, 2011: The Madden-Julian Oscillation and the relative value of deterministic forecasts of extreme precipitation in the contiguous United States. *Journal of Climate,* **24,** 2421-2428.

Application of a simple economic value model to CFSR.v1 forecasts of 90th extreme precipitation

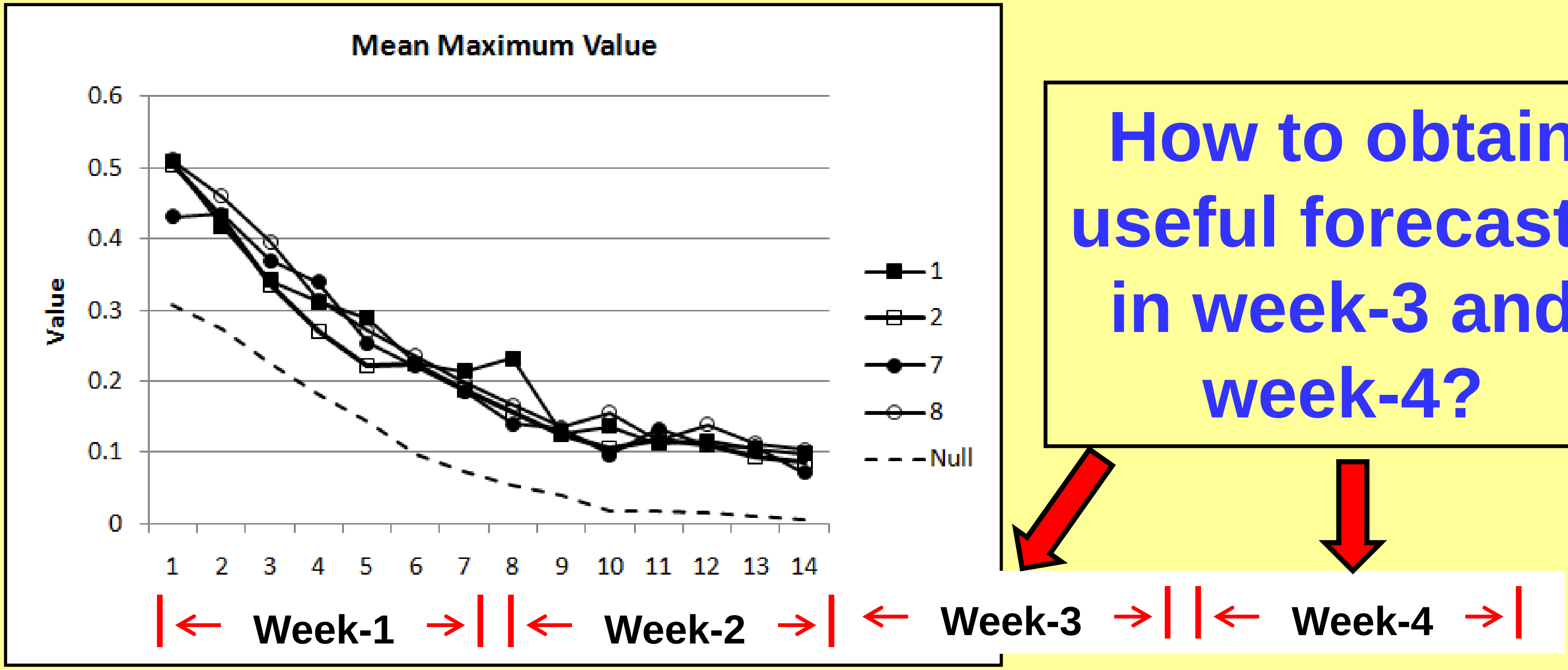


Cost/loss ratio decision model $V = \dfrac{\min(\alpha,\ s) - F(1-s)\alpha + Hs(1-\alpha) - s}{\min(\alpha, s) - s\alpha}$

Where V is value, α = user's cost/loss ratio (C/L), **s** = climatological base rate of the event (90th extreme), **H** = hit rate, **F** **=** false alarm rate

When α = **s** **potential (or maximum) forecast value**

And the challenge is ……..



How to obtain useful forecasts in week-3 and week-4?

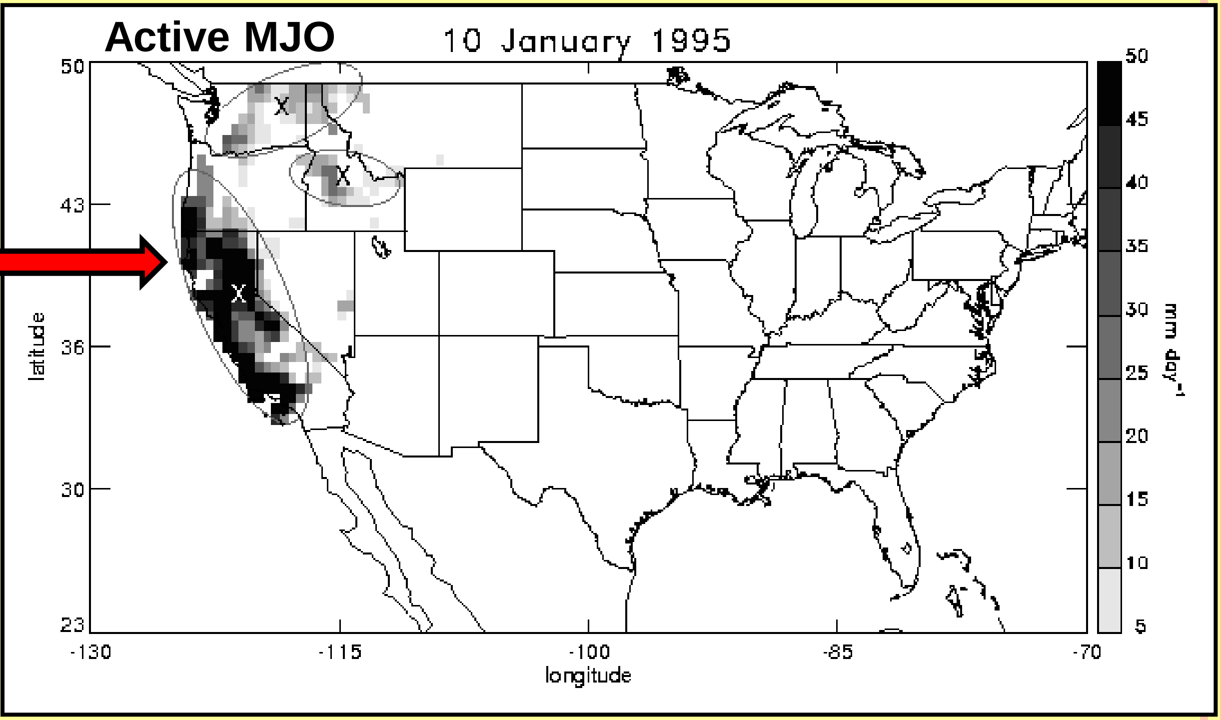
Work in progress

- ❑ Investigating how the MJO modulates the spatiotemporal variability of precipitation
- ❑ Developing metrics of probabilistic forecasts of precipitation in Weeks 3-4

Observations

Only gridpoints with P > 90th percentile

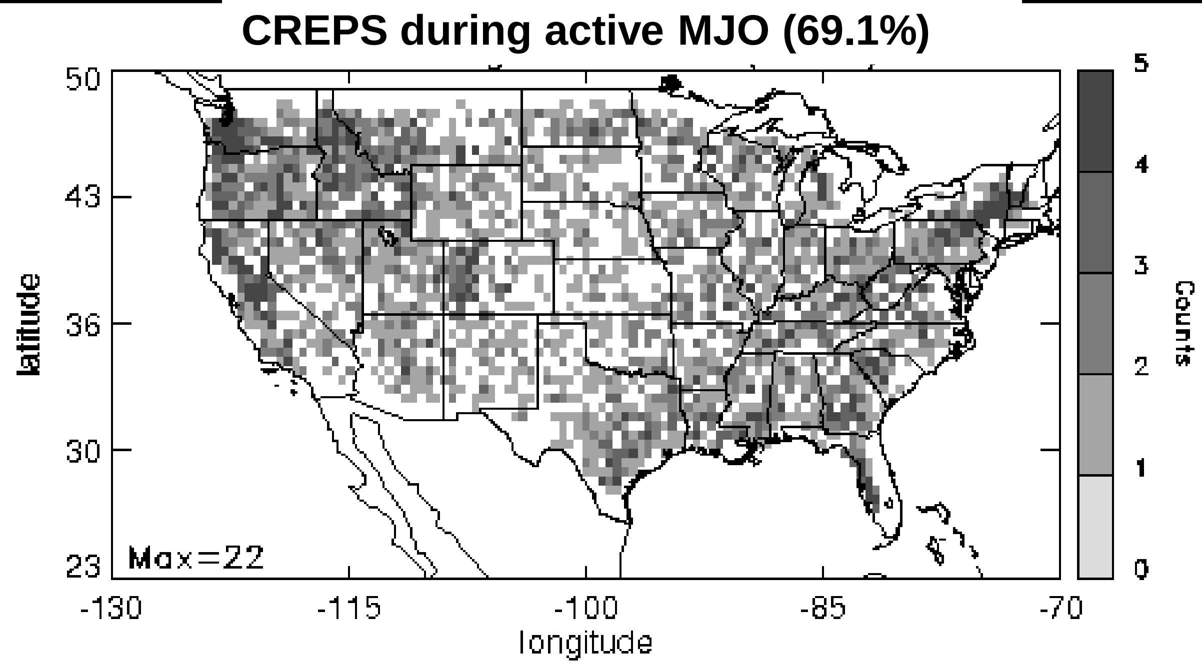
CREP: P in gridpoint > 90th percentile, area of connected gridpoints > 90th percentile of areas of extreme P

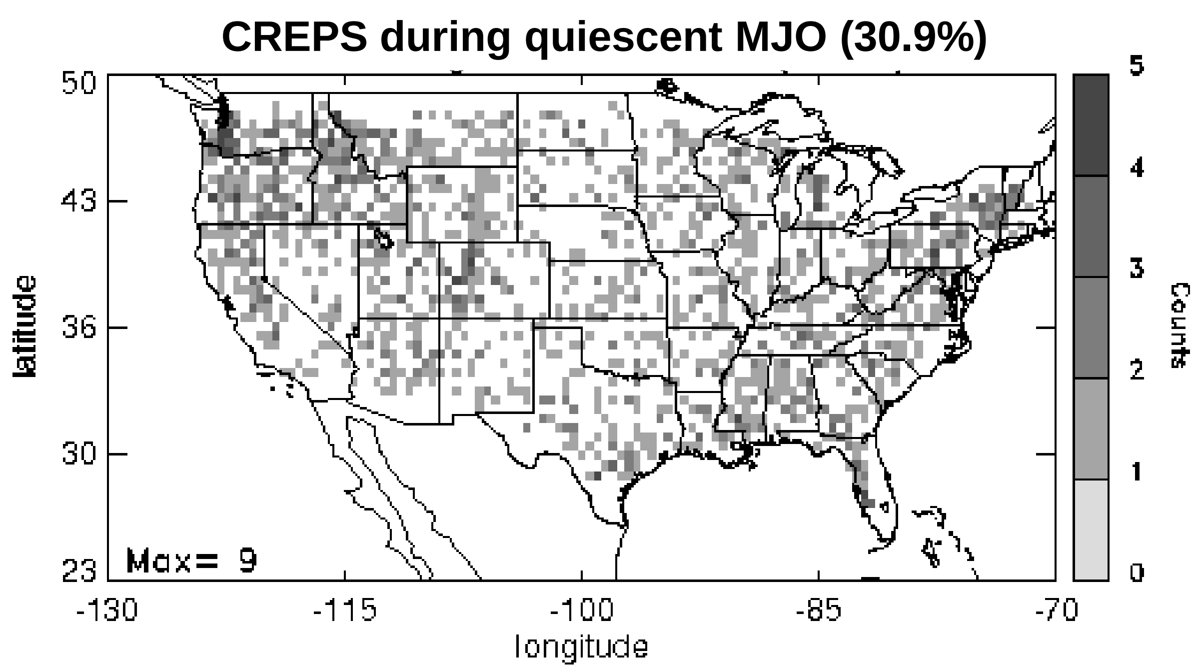


For each CREP:

- Day of occurrence
- If MJO was active, in what phase, amplitude
- Mean precipitation, area, center
- Probabilities of CREP with different intensities and areas conditioned on MJO

Counts assigned to center of each CREP (1 November-31 March, 1979-2010). Total: **5600**.





Joint probabilities of CREPs during active and inactive MJO days

$P(C_{PX} \cap MJO_{day})$: joint probability of C_{PX} and MJO being active

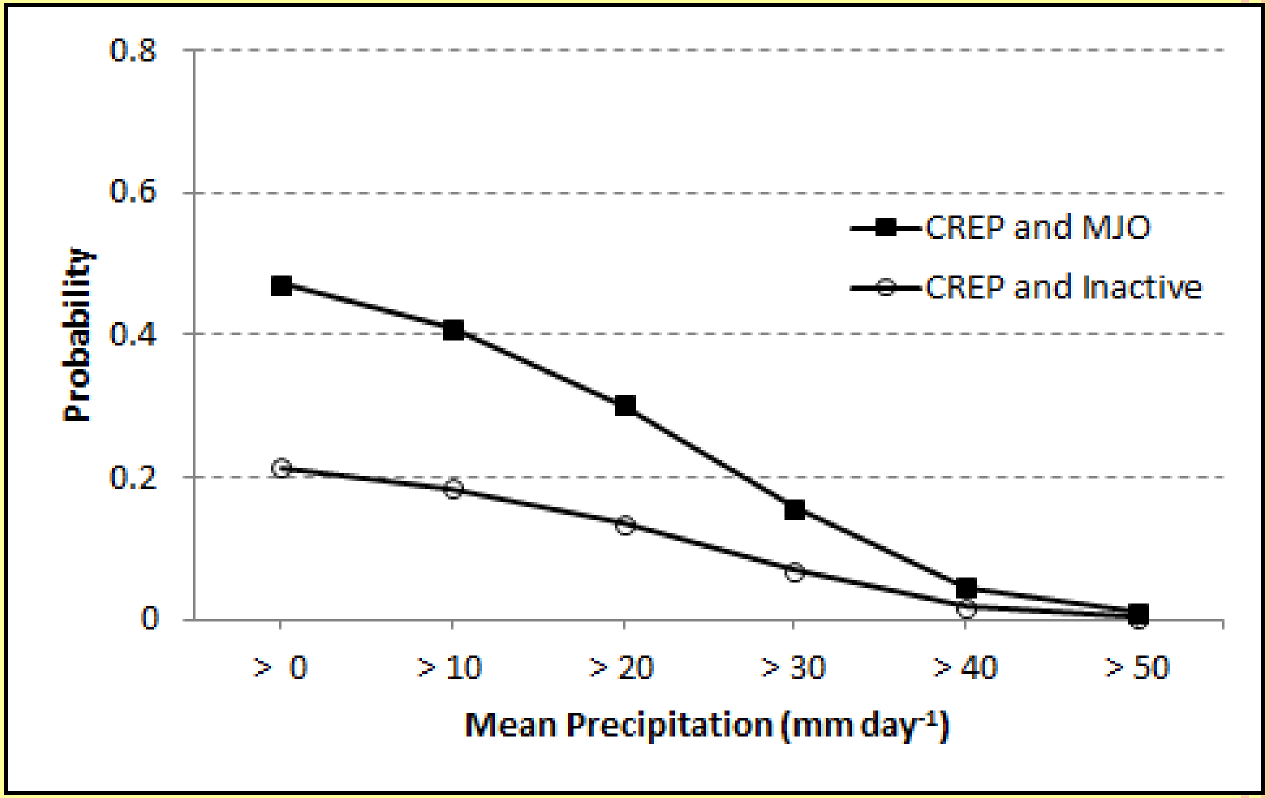
Where:

C_{PX}: one or more CREPs anywhere in the CONUS with mean precipitation exceeding P_x mm day^{-1};

MJO_{day}: an active MJO day (in any phase);

Similarly for:

$P(C_{PX} \cap INA_{day})$: joint probability of C_{PX} and MJO being inactive



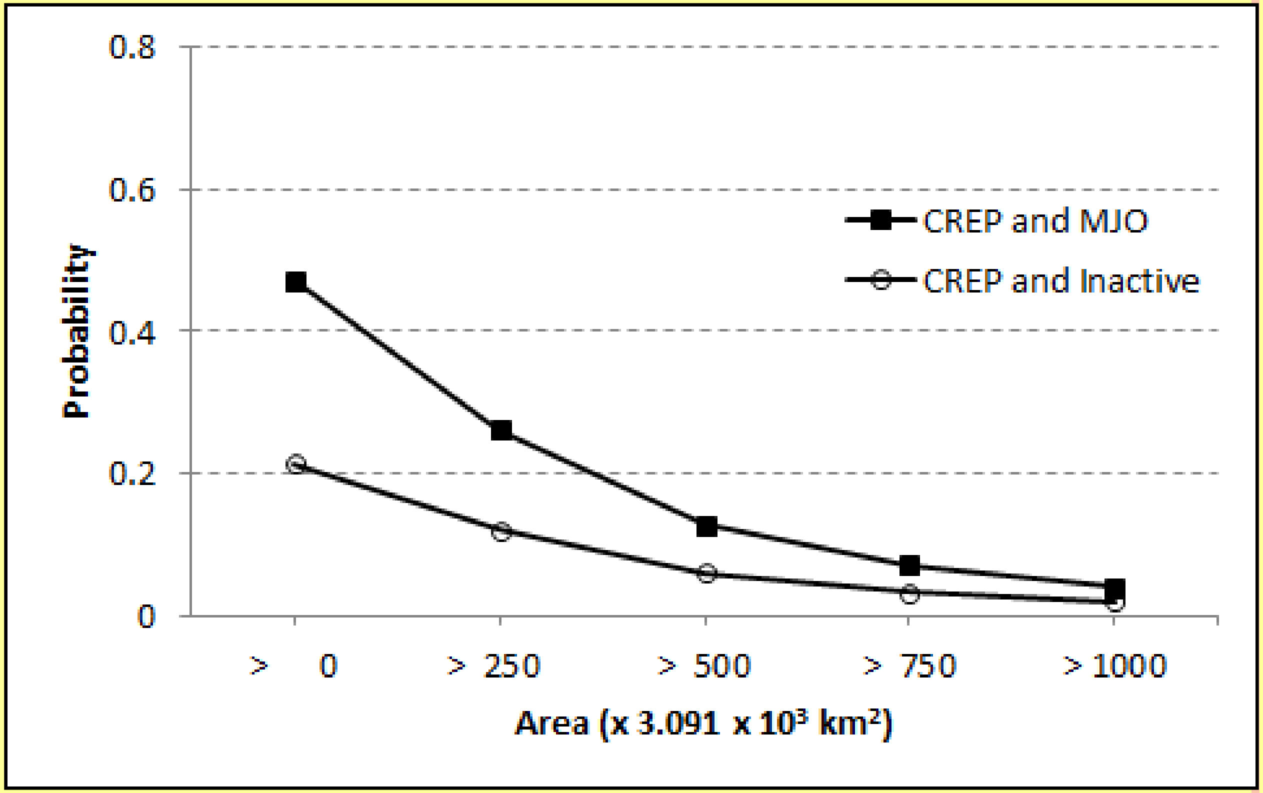
Joint probabilities of CREPs during active and inactive MJO days

$P(C_{AX} \cap MJO_{day})$: joint probability of C_{AX} and MJO being active,

Where:

C_{AX}: one or more CREPs anywhere in the CONUS with area exceeding A_X km^2

MJO_{day}: an active MJO day (in any phase)

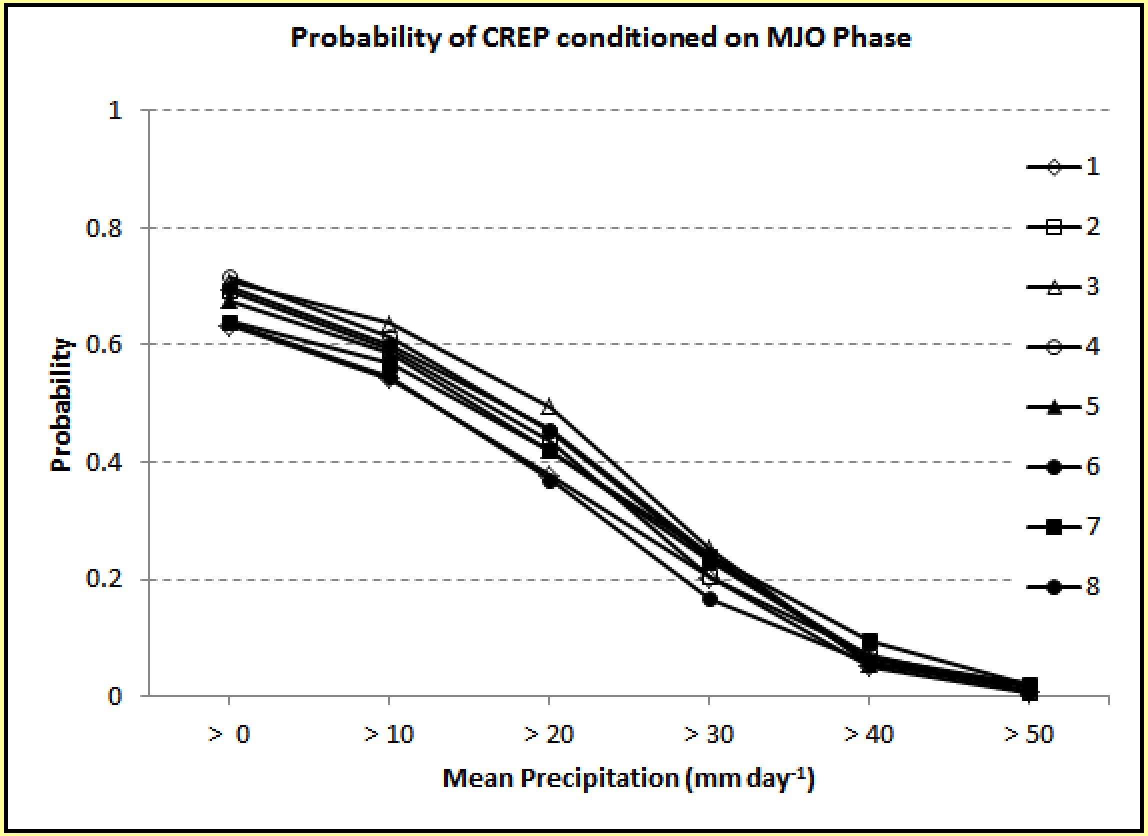


Probabilities of CREPs conditioned on MJO phase

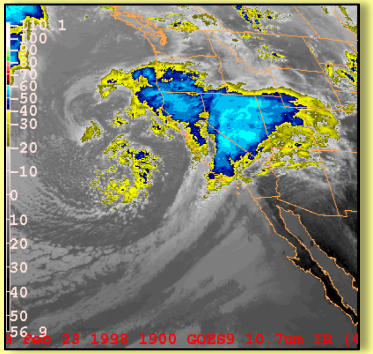
$P(C_{PX} / MJO_{\Phi})$: conditional probability of C_{PX} given that MJO is active and in phase Φ (1-8)

Where:

C_{PX}: one or more CREPs anywhere in the CONUS with mean precipitation exceeding P_x mm day^{-1}



MJO and extreme precipitation

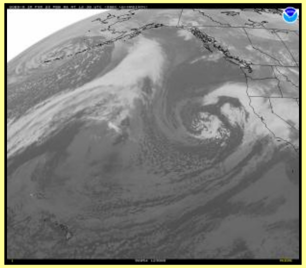


- **Forecast skill of extreme precipitation is usually higher when the MJO is active and has enhanced convection occurring over the western hemisphere, Africa, and/or the western Indian Ocean than in quiescent periods.**
- **HSS greater than 0.1 extends to lead times of up to two weeks in these situations.**
- **Occurrences of CREPS over the CONUS are significantly higher when the MJO is active (69.1%) than during inactive days (30.9%).**
- **The probability of occurring one or more CREPs over the CONUS is nearly twice as large when the MJO is active than in quiescent days.**


Daily Nexus

Clinton Declares State of Emergency

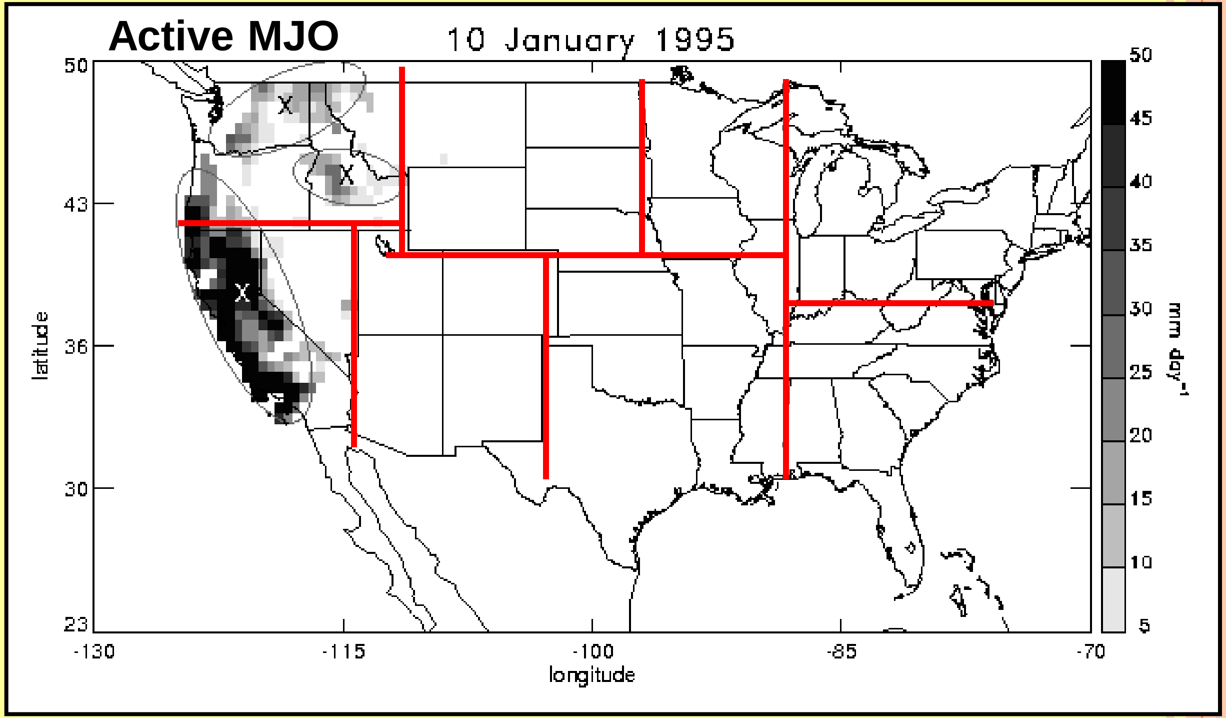
Santa Barbara Wiped Out by Record Inches



Work in progress

- Evaluating skill of probabilistic forecasts of precipitation in Weeks 3-4

Predictand:
S_J is percentage of CONUS sector with average precipitation in Week-K > Threshold (50th, 75th, 90th percentiles)



Identification of MJO

- NCEP/NCAR reanalysis: U200, U850 intraseasonal anomalies
- combined EOF
- Phase diagram from PC1/PC2
- MJO event has amplitude > 0.9
- Phase rotates anti-clockwise
- 81 MJO events during 1 Nov-31 Mar, 1979-2010

(phases ~Wheeler and Hendon 2004)

Enhanced convection